

Community Ecology

Community · Habitat · Niche · Gause's Principle · Niche Overlap

Based on your class notes · 50+ questions with model answers · 11 labelled diagrams

Section	Type	What it contains
A	Very short (1-2 marks)	20 one-line definitions & facts
B	Short answer (3-5 marks)	10 questions with diagrams
C	Long answer (8-10 marks)	6 full essay answers with illustrations
D	Differentiate	5 comparison tables
E	MCQs	15 case-based MCQs + answer key
F	Last-minute revision	Key names, years & diagrams to practise

Levels of ecological organisation



Each level adds a new property: interbreeding → species interactions → energy & nutrient flow

Fig. 1 — Where a community sits in the levels of ecological organisation.

Section A — Very Short Answers

1-2 marks each · learn these word-perfect

#	Question	Model answer
1	Define species.	A group of actually or potentially interbreeding natural populations that is reproductively isolated from other such groups (biological species concept, Mayr).
2	Define population.	A group of individuals of the same species occupying a particular area at a specific time, within which individuals can exchange genetic information.
3	Define biotic community.	An assemblage of populations of different species living together in a defined habitat and interacting with one another; a complex assemblage of microbial, plant and animal populations.

#	Question	Model answer
4	What is a habitat?	The physical place or natural area where an organism lives, providing its food, shelter and conditions for breeding — the organism's 'address'.
5	Who classified communities into major and minor?	S. C. Kendeigh (1974).
6	What is a major community?	A large community which, together with its habitat, forms a more or less complete and self-sustaining unit (ecosystem), dependent only on solar energy from outside — e.g. a forest, a pond.
7	What is a minor community (society)?	A secondary aggregation within a major community that is not independent for energy circulation — e.g. organisms on a rotting log within a forest.
8	Define ecological niche.	The specific position and functional status (total role) of a species within its community (Smith, 1977; Whittaker, 1976).
9	Name the three types of niche.	(i) Spatial or habitat niche, (ii) trophic niche, (iii) multidimensional or hypervolume niche.
10	Who coined the term 'niche'? Who proposed the hypervolume niche?	Joseph Grinnell (1917) first used 'niche'; Charles Elton (1927) gave the functional/trophic idea; G. E. Hutchinson (1957) proposed the n-dimensional hypervolume niche.
11	Who studied spatial niche in millipedes?	O'Neill (1967) — seven millipede genera occupying different microhabitats of a maple-oak forest log.
12	Define trophic niche.	The trophic (feeding) position of a species in relation to its food in the community — what it eats and who eats it.
13	Define niche width.	The range of ecological functions or resources a species uses — Van Valen (1965).
14	What is ecological equivalence?	When unrelated species in different geographical areas occupy similar niches and show similar basic adaptations — e.g. kangaroo (Australia) and bison (N. America) as large grazers.
15	State Gause's principle.	No two species can occupy the same niche in the same community indefinitely; one will out-compete and eliminate the other (competitive exclusion, G. F. Gause, 1934).
16	Who gave the phrase 'complete competitors cannot coexist'?	Garrett Hardin (1960).
17	Which Paramecium survived in Gause's mixed culture of <i>P. aurelia</i> and <i>P. caudatum</i> ?	<i>P. aurelia</i> ; <i>P. caudatum</i> was eliminated in about 16 days.
18	Why can <i>P. bursaria</i> live at the low-O ₂ bottom of a culture tube?	It harbours symbiotic green algae (zoochlorellae) that photosynthesise and supply oxygen.
19	What is a fundamental niche?	The full range of conditions and resources in which a species could survive and reproduce in the absence of competitors.
20	What is a realised niche?	The part of the fundamental niche a species actually occupies, after being restricted by competition and other interactions.

Section B — Short Answers

3-5 marks each · write 8-12 lines + a diagram where shown

Q1. Describe the types of biotic community according to Kendeigh.

[4]

Answer. Kendeigh (1974) divided biotic communities into two types:

- **Major community** — large, well organised; together with its habitat forms a nearly complete, self-sustaining ecosystem. It depends on the outside only for solar energy. e.g. a forest, grassland, pond.
- **Minor community (society)** — a smaller, secondary aggregation within a major community. It is not independent for energy circulation; it relies on the major community. e.g. organisms living in a rotting log, or the insect community of one tree in a forest.

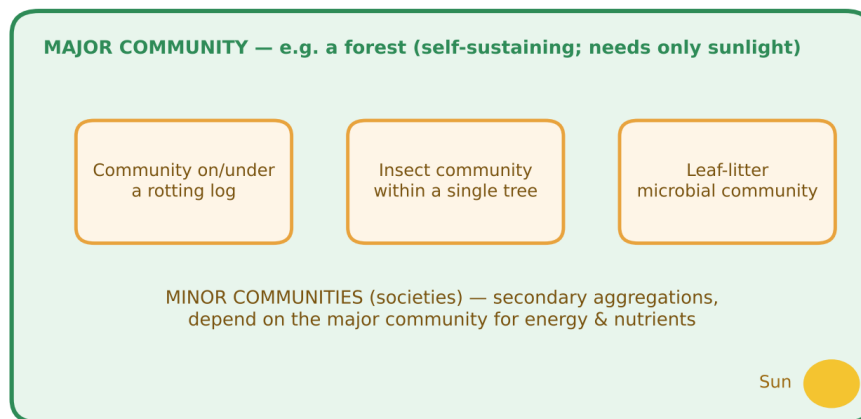


Fig. 2 — Minor communities nested inside a major community.

Q2. Distinguish between habitat and niche.

[3]

Answer. Habitat is **where** a species lives; niche is **what it does** there.

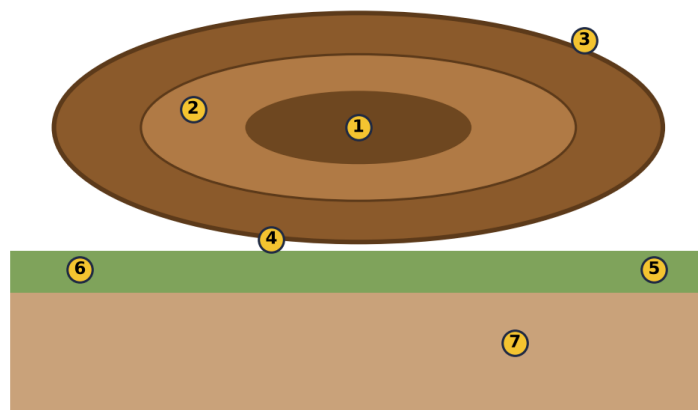
- Niche is the specialised ecological function of a species; habitat is the place where it is performed.
- Niche is like a 'profession'; habitat is the 'address' where that profession is carried out.
- Different species may share a common habitat, but their niches always differ — in (a) period of activity, (b) breeding season, (c) cover used, (d) feeding behaviour.



Q3. What is spatial niche? Explain with O'Neill's millipede example.

[5]

Answer. The **spatial (habitat) niche** concerns the physical space occupied by an organism. O'Neill (1967) found seven millipede genera on one log in a maple-oak forest, each in a different microhabitat, so they could coexist:



Millipede genus — microhabitat

- 1 Euryurus — inside decomposed heartwood
- 2 Pseudopolydesmus — superficial wood
- 3 Narceus — outer surface of log
- 4 Scytonotus — under the log
- 5 Fontaria — on the ground surface
- 6 Cleidogona — within leaf litter
- 7 Abacion — beneath litter, on soil

Fig. 3 — Vertical and horizontal separation of millipedes on a fallen log.

Although all seven share one habitat (the log), each occupies a distinct spatial niche, reducing competition.

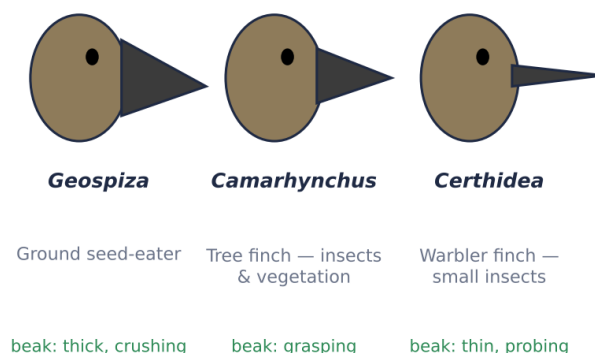
Q4. Explain trophic niche with suitable examples.

[5]

Answer. The **trophic niche** is the feeding position of a species relative to its food in the community.

- **Darwin's finches (Galápagos):** three genera share the same macrohabitat but feed differently — *Geospiza* (ground seed-eaters, thick crushing beaks), *Camarhynchus* (tree finches, insects/vegetation), *Certhidea* (warbler finch, small insects, thin beak). Beaks are modified to suit food.
- **Aquatic bugs in a pond:** *Notonecta* is a predator, *Corixa* a detritivore — same pond, different trophic niche.
- **Indian major carps in composite fish culture:** Catla (surface), Rohu (column), Mrigal (bottom) feed at different levels — so they are stocked together without competing.

Galápagos finches — beak fits food



Pond fishes — same habitat, different zone/food

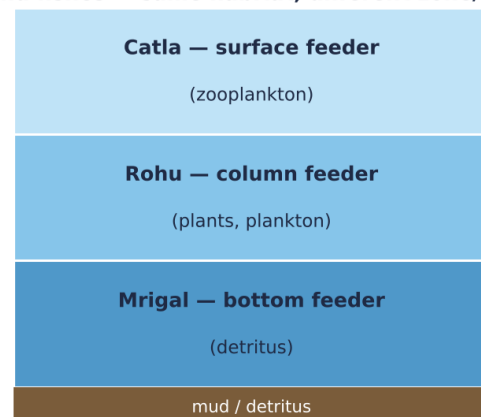


Fig. 4 — Trophic niche separation by beak shape and feeding zone.

Q5. What is the multidimensional (hypervolume) niche?

[4]

Answer. Proposed by **G. E. Hutchinson (1957)**. The niche is defined by the range of every environmental variable within which a species can live and reproduce.

Plot the tolerance range of temperature on one axis and humidity on another: the enclosed area is a two-dimensional niche (a box, if the variables are independent). Add a third variable (e.g. pH) to get a volume. With n variables (food size, light, salinity...) the niche becomes an **n -dimensional hypervolume**.

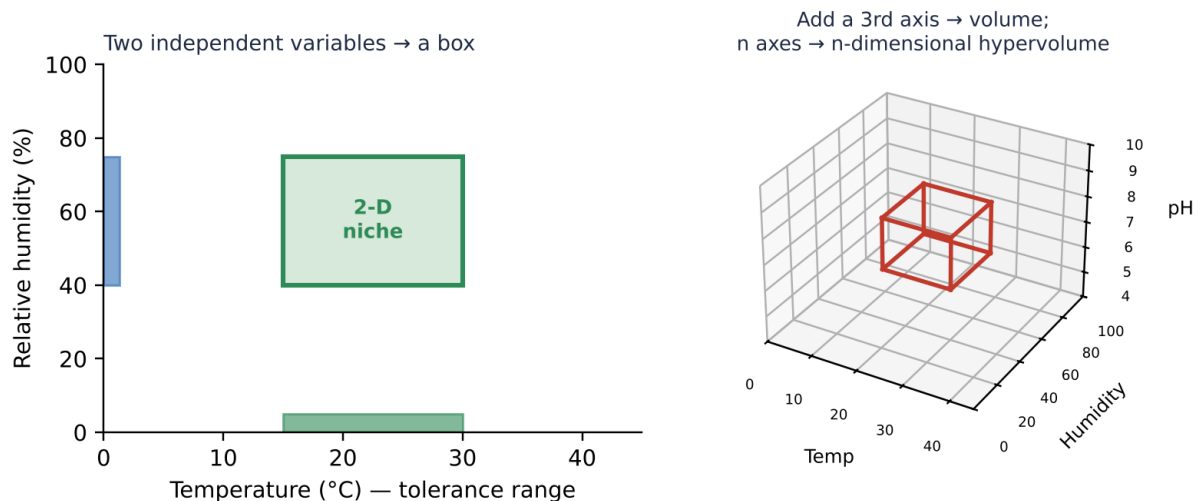


Fig. 5 — Building a niche from tolerance ranges.

Q6. What is niche width? On what factors does it depend?

[4]

Answer. **Niche width (breadth)** is the range of ecological functions or resources used by a species (Van Valen, 1965). Species with narrow niches are **specialists**; those with broad niches are **generalists**.

Factors: (a) food, (b) predation, (c) parasites, (d) reproductive potential and mortality, (e) development of offspring, (f) seasonal activity, (g) inter- and intraspecific competition. Interspecific competition narrows the niche; intraspecific competition widens it.

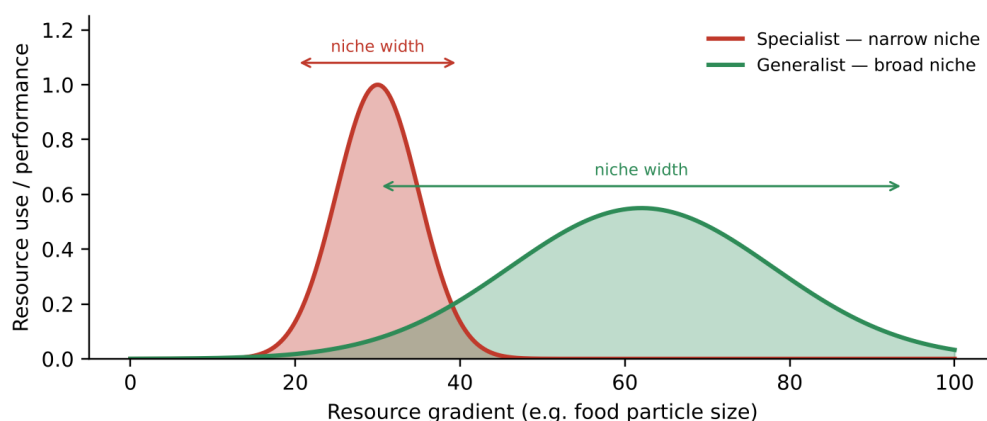


Fig. 6 — Niche width of a specialist vs a generalist.

Q7. What is ecological equivalence? Give examples.

[4]

Answer. Unrelated species in different geographical regions that occupy similar niches and show similar basic adaptations are called **ecological equivalents** (a result of convergent evolution).

Region 1	Region 2	Shared niche
Little auk (order of gulls/auks), N. hemisphere	Magellanic diving petrel (order of albatrosses), S. hemisphere	Small diving seabirds
Yellow-throated longclaw (African motacillid)	Meadowlark (American icterid)	Grassland insect-eating birds; nearly identical in look
Kangaroo (<i>Macropus</i>), Australia	Bison, North America	Large grassland grazers

Q8. Why could *P. bursaria* and *P. caudatum* coexist in Gause's experiment? [4]

Answer. Although both ate yeast, they used it in **different places** of the culture tube:

- *P. caudatum* fed on yeast/bacteria **suspended** in the upper medium.
- *P. bursaria* fed on yeast **settled at the bottom**, where oxygen is low — it survives there because of its symbiotic green algae.

Occupying different niches avoided competition, so both survived (Fig. 9C).

Q9. What is niche overlap? What are its consequences? [4]

Answer. When two species use part of the same resource range, their niches overlap.

- **Small overlap** — the species coexist, essentially in separate niches.
- **Complete overlap** — the more efficient species drives the other to local extinction through interspecific competition (Gause's principle).
- **Example:** parasitic Hymenoptera (wasps) attacking sawfly cocoons — the indigenous species overlapped in distribution, yet each held its own position in niche space and some developed zones of dominance over others (Price, 1971).

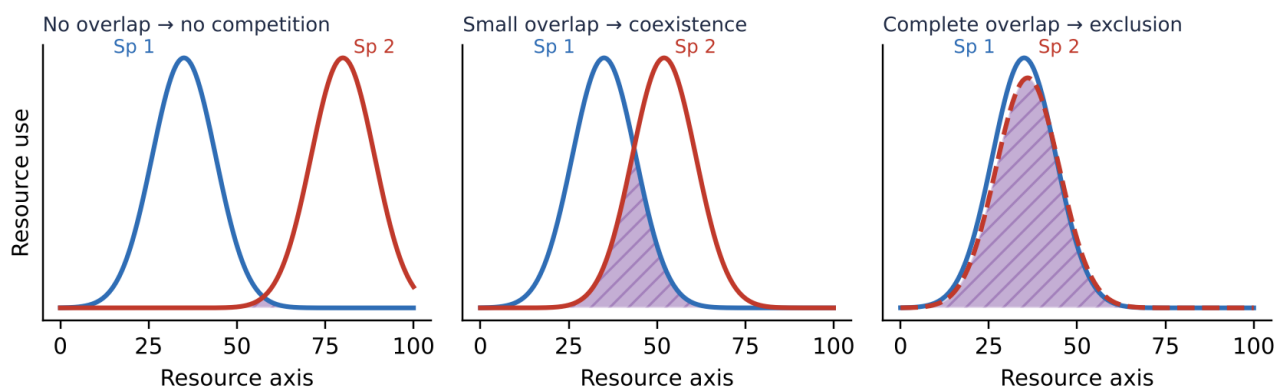


Fig. 7 — Degree of niche overlap decides competition.

Q10 Distinguish fundamental and realised niche with an example. [4]

Answer. The **fundamental niche** is where a species *could* live without competitors; the **realised niche** is where it *actually* lives because competition restricts it.

Classic example (Connell, 1961): the barnacle *Chthamalus* can live from the high to low tide line, but *Balanus* smothers and crowds it out of the lower zone. So its realised niche is only the upper shore.

Fundamental vs realised niche — barnacles on a rocky shore (Connell, 1961)

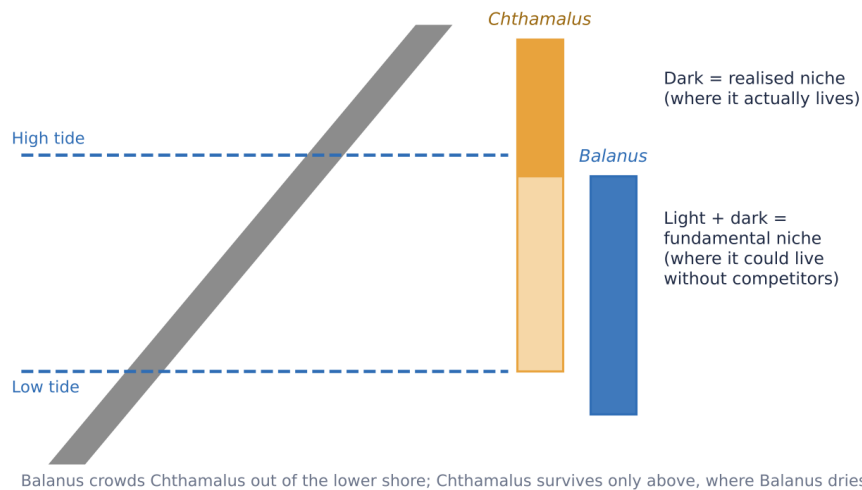


Fig. 8 — Competition shrinks the fundamental niche to the realised niche.

Section C — Long Answers

8-10 marks · structure: definition → explanation → diagram → example → conclusion

Q1. Briefly describe Gause's principle of competitive exclusion with illustration. (One niche, one species concept)

[10]

Answer. 1. Principle. According to G. F. Gause (1934), Russian biologist, **no two species can occupy the same niche in a single community**. If they try, one will always be superior and drive the other to local extinction through competition. Hence, for different species to coexist, there must be some difference between their niches. The idea was later re-stated by **Hardin (1960)** as 'complete competitors cannot coexist'.

2. Experiment 1 — *P. aurelia* and *P. caudatum*. Grown separately in yeast/bacterial culture, both showed normal sigmoid growth. Grown together, only *P. aurelia* remained after about 16 days. Both fed on the same suspended food (identical niche). *P. aurelia* grew faster and converted food into offspring more efficiently, so it overwhelmed *P. caudatum*.

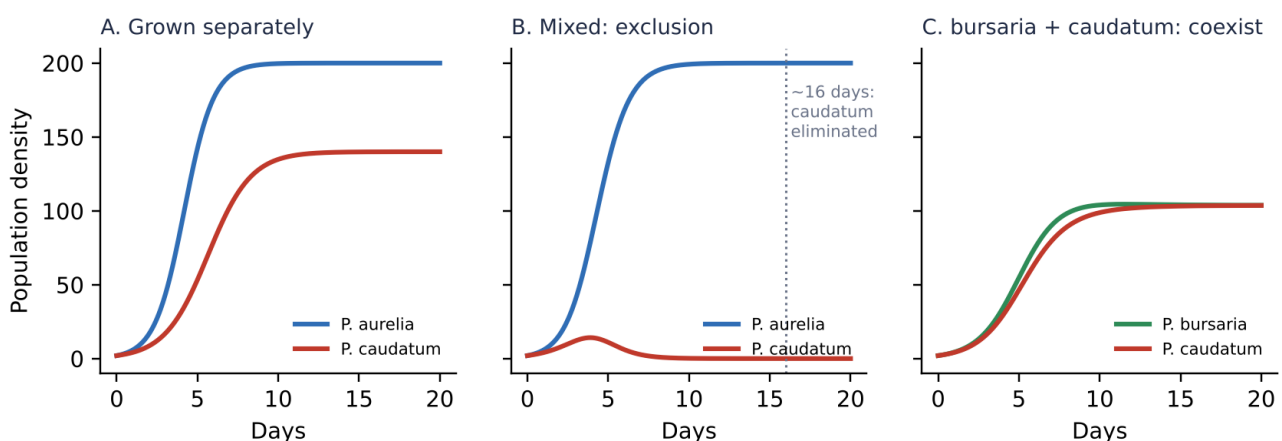
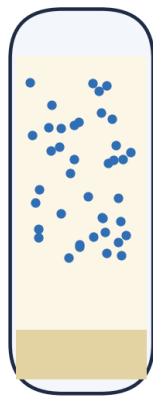


Fig. 9 — Gause's results: (A) alone, (B) aurelia excludes caudatum, (C) bursaria and caudatum coexist.

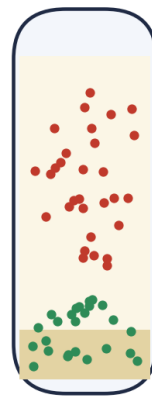
3. Experiment 2 — *P. bursaria* and *P. caudatum*. When *P. aurelia* was replaced by *P. bursaria*, both species survived although their food requirement was the same. *P. caudatum* fed on suspended yeast in the upper medium, while *P. bursaria* fed on yeast settled at the oxygen-poor bottom (helped by its symbiotic green algae). Living in different parts of the chamber = different niches = coexistence.

Exp. 1: aurelia + caudatum



only *P. aurelia* left
(same niche:
suspended yeast)

Exp. 2: bursaria + caudatum



P. caudatum —
feeds on suspended
yeast/bacteria (upper)

P. bursaria — settled yeast,
low-O₂ bottom (has
symbiotic green algae)

Yeast settled at the bottom = a separate food niche → coexistence

Fig. 10 — Gause's principle simplified (culture tubes).

4. Inference. Species with complete competition cannot coexist. Coexistence requires **niche partitioning** (resource partitioning). A heterogeneous environment offers more niches and allows coexistence; a homogeneous environment intensifies competition and lowers diversity.

5. Significance. Explains niche differentiation, character displacement, Darwin's finches, composite fish culture and why introduced competitors can eliminate native species.

Exam tip: Draw both figures — the test tubes and the population-vs-time graphs. Label '*P. aurelia*', '*P. caudatum*', 'culture medium', axes 'No. of individuals' and 'Time'.

Q2. Define ecological niche. Describe its different types with examples.

[10]

Answer. The niche of a species is its specific position and functional status, or total role, within the community (Smith, 1977; Whittaker, 1976). Grinnell (1917) stressed habitat, Elton (1927) the functional role, and Hutchinson (1957) the n-dimensional hypervolume.

A. Spatial or habitat niche — the physical space occupied. e.g. seven millipede genera on one log (O'Neill, 1967): *Euryurus* in decomposed heartwood, *Pseudopolydesmus* in superficial wood, *Narceus* on the outer surface, *Scytonotus* under the log, *Fontaria* on the ground surface, *Cleidogona* within leaf litter, *Abacion* beneath litter on soil (Fig. 3).

B. Trophic niche — the feeding position relative to food. e.g. Darwin's finches *Geospiza*, *Camarhynchus*, *Certhidea* with beaks modified for seeds, insects and small insects; pond bugs *Notonecta* (predator) and *Corixa* (detritivore); Catla, Rohu, Mrigal (Fig. 4).

C. Multidimensional / hypervolume niche — the range of all environmental variables in which the species can live and reproduce. Temperature tolerance on one axis and humidity on another give a 2-D box; adding more variables gives an n-dimensional hypervolume (Fig. 5).

Also mention: fundamental vs realised niche (Fig. 8) and niche width (Fig. 6).

Conclusion: no two species have identical niches in a stable community; niche separation is what allows many species to share one habitat.

Q3. What is a biotic community? Classify communities and differentiate major from minor communities.

[8]

Answer. A biotic community is an assemblage of different populations living in a defined habitat and interacting with one another. A monospecific assemblage is a population; an assemblage of different kinds of populations is a community — a complex assemblage of microbial, plant and animal populations.

Classification (Kendeigh, 1974): major and minor communities (see Section B Q1 and Fig. 2). Communities may also be named by dominant species (e.g. sal forest), physical habitat (e.g. sandy shore) or functional unit.

Major community	Minor community
Independent except for solar energy	Not independent
Forms a self-sustaining unit (ecosystem)	Cannot form a self-sustaining unit
Not dependent on a minor community	Dependent on the major community
Large, well organised	Small, a secondary aggregation (society)
e.g. a forest, a pond	e.g. community of a tree or log within the forest

Characteristics of a community: species diversity, growth form and structure (stratification), dominance, succession, trophic structure and relative abundance.

Q4. Explain niche overlap and niche partitioning. How do they relate to competitive exclusion? [8]

Answer. Niche overlap is the shared use of a resource by two or more species (Fig. 7). With small overlap species coexist; with complete overlap the more successful species drives the less successful one into extinction through interspecific competition.

Example: parasitic Hymenoptera attacking sawfly cocoons — native species overlapped in distribution, yet each held its own position in niche space; some developed zones of dominance (Price, 1971).

Niche partitioning is the division of resources (space, food, time) so that competing species can coexist — e.g. millipedes on a log, finch beaks, Catla-Rohu-Mrigal, *P. bursaria* vs *P. caudatum*, MacArthur's warblers feeding in different parts of a spruce tree.

Relation to Gause: complete overlap → competitive exclusion; partial overlap + partitioning → coexistence. Hardin (1960): two complete competitors cannot coexist; if they do, there must be ecological niche partitioning. Heterogeneous habitats allow coexistence and higher diversity.

Q5. With suitable diagrams, explain the hypervolume niche and the fundamental vs realised niche. [8]

Answer. Hutchinson (1957) defined the niche as an **n-dimensional hypervolume**: each axis is an environmental variable (temperature, humidity, pH, food size...), and the niche is the region where the species can survive and reproduce (Fig. 5).

The full hypervolume available in the absence of competitors is the **fundamental niche**. Interactions — especially competition — restrict the species to a smaller part, the **realised niche**.

Example: Connell's barnacles — *Chthamalus* could live throughout the intertidal zone but is restricted to the upper shore by *Balanus* (Fig. 8). Removing *Balanus* lets *Chthamalus* spread down — proof that its fundamental niche is larger than its realised niche.

In your notes: fundamental niche = where the organism could be present throughout the habitat; realised niche = where it actually is, occupying a particular space due to competition.

Q6. Write notes on: (a) niche width, (b) ecological equivalence, (c) species and population. [3+3+2]

Answer. (a) Niche width — the range of ecological functions a species performs (Van Valen, 1965); depends on food, predation, parasites, reproductive potential and mortality, offspring development, seasonal activity and competition. Specialists narrow, generalists broad (Fig. 6).

(b) Ecological equivalence — unrelated species in different geographical areas occupying similar niches with similar adaptations: little auk vs Magellanic diving petrel; yellow-throated longclaw vs meadowlark; kangaroo vs bison.

(c) Species — interbreeding natural populations reproductively isolated from other groups.

Population — individuals of one species in a particular area at a specific time, able to exchange genetic information.

Section D — Differentiate Between

Write as a two-column table in the exam

1. Habitat vs Niche

Habitat	Niche
Place where a species lives ('address')	Functional role of the species ('profession')
Physical / spatial concept	Functional + spatial + trophic concept
Shared by many species	Unique to one species in a community
Can be seen directly	An abstract concept
e.g. pond	e.g. Notonecta as predator in the pond

2. Fundamental vs Realised niche

Fundamental niche	Realised niche
Potential niche without competitors	Actual niche with competitors
Larger	Smaller (part of the fundamental)
Theoretical	Observed in nature
e.g. Chthamalus on whole shore	e.g. Chthamalus on upper shore only

3. Spatial vs Trophic vs Hypervolume niche

Spatial	Trophic	Hypervolume
Physical space occupied	Feeding position	Range of all environmental variables
O'Neill — millipedes	Darwin's finches; Catla-Rohu-Mrigal	Hutchinson (1957)
One dimension: space	One dimension: food	n dimensions

4. Specialist vs Generalist

Specialist	Generalist
Narrow niche width	Broad niche width
Uses few resources efficiently	Uses many resources
Sensitive to change	Tolerant of change
e.g. koala (eucalyptus)	e.g. crow, cockroach

5. Population vs Community

Population	Community
Individuals of one species	Populations of many species

Population	Community
Interbreeding possible	Interbreeding between species not possible
Attributes: density, natality, mortality	Attributes: diversity, dominance, stratification

Section E — Case-Based MCQs

Choose one · answer key at the end

- A forest is self-sustaining, but the community within a fallen log depends on the forest's leaf fall. The log community is a:
(A) Biome (B) Minor community (C) Major community (D) Population
- Which pair correctly matches Kendeigh's major community?
(A) Pond — self-sustaining except sun (B) Log — self-sustaining (C) Leaf litter — independent (D) Tree hole — independent
- Two warblers share a spruce tree but feed in different branches. This best illustrates:
(A) Niche partitioning (B) Ecological equivalence (C) Commensalism (D) Competitive exclusion
- In Gause's mixed culture, *P. caudatum* disappeared because:
(A) Yeast was toxic (B) Oxygen ran out (C) *P. aurelia* was a predator (D) Both occupied an identical niche and *P. aurelia* was more efficient
- P. bursaria* survives at the oxygen-poor bottom of the tube because it:
(A) Eats *P. caudatum* (B) Is anaerobic (C) Has symbiotic green algae (D) Forms cysts
- The seven millipede genera on one log (O'Neill) show:
(A) Hypervolume niche (B) Ecological equivalence (C) Trophic niche (D) Spatial niche
- Catla, Rohu and Mrigal are cultured together because they have different:
(A) Feeding zones (trophic niches) (B) Species concepts (C) Breeding seasons only (D) Habitats
- Plotting a species' temperature and humidity tolerance as a box represents:
(A) Habitat (B) Niche width (C) Realised niche (D) A 2-D portion of the hypervolume niche
- Kangaroo and bison are:
(A) Ecological equivalents (B) Competitors (C) Close relatives (D) Same niche, same habitat
- Removing *Balanus* allows *Chthamalus* to colonise the lower shore. This shows *Chthamalus*':
(A) Fundamental niche is larger than realised (B) Habitat changed (C) Niche width is zero (D) Realised niche is larger than fundamental
- Niche width was defined by:
(A) Kendeigh (B) Gause (C) Van Valen (D) Hardin
- 'Complete competitors cannot coexist' was stated by:
(A) Odum (1971) (B) Hardin (1960) (C) Elton (1927) (D) Gause (1934)
- Two species show complete niche overlap in a uniform lab culture. Expected outcome:
(A) Mutualism (B) Both increase (C) Stable coexistence (D) Exclusion of the weaker competitor
- Interspecific competition usually makes a species' niche:
(A) Narrower (B) Multidimensional (C) Broader (D) Unchanged
- A heterogeneous environment, compared with a homogeneous one, generally:
(A) Allows more coexistence and higher diversity (B) Has no niches (C) Increases exclusion (D) Lowers diversity

Answer key: 1 B · 2 A · 3 A · 4 D · 5 C · 6 D · 7 A · 8 D · 9 A · 10 A · 11 C · 12 B · 13 D · 14 A · 15 A

Section F — Last-Minute Revision

Names, years and diagrams examiners look for

Scientist	Year	Contribution
J. Grinnell	1917	First used 'niche' (habitat-based)
C. Elton	1927	Functional / trophic niche
G. F. Gause	1934	Competitive exclusion — Paramecium experiments
G. E. Hutchinson	1957	n-dimensional hypervolume niche
G. Hardin	1960	'Complete competitors cannot coexist'
J. H. Connell	1961	Barnacles — fundamental vs realised niche
L. Van Valen	1965	Niche width
R. V. O'Neill	1967	Spatial niche of millipedes
P. W. Price	1971	Niche overlap in parasitic Hymenoptera
S. C. Kendeigh	1974	Major and minor communities
Whittaker; Smith	1976; 1977	Definition of niche

Diagrams to practise (2 minutes each):

- Gause's test tubes + population graphs (Figs. 9–10) — **most frequently asked**
- Niche overlap — small vs complete (Fig. 7)
- Niche width bell curve (Fig. 6)
- Millipedes on a log (Fig. 3)
- Hypervolume box (Fig. 5)
- Barnacle zonation (Fig. 8)

Watch out: Your class notes write Gause's principle as 'two species can occupy the same niche' — the correct statement is '**no two species can occupy the same niche**'. Use the corrected version in the exam.